ROLL NO. _____

Code: AE61 **Subject: CONTROL ENGINEE**

AMIETE – ET

Time: 3 Hours **JUNE 2013** **Max. Marks: 100**

PLEASE WRITE YOUR ROLL NO. AT THE SPACE PROVIDED ON EACH PAGE IMMEDIATELY AFTER RECEIVING THE QUESTION PAPER.

NOTE: There are 9 Questions in all.

- **Question 1 is compulsory and carries 20 marks. Answer to Q.1 must be written in the space provided for it in the answer book supplied and nowhere else.**
- **The answer sheet for the Q.1 will be collected by the invigilator after 45 minutes of the commencement of the examination.**
- **Out of the remaining EIGHT Questions answer any FIVE Questions. Each question carries 16 marks.**
- **Any required data not explicitly given, may be suitably assumed and stated.**

Q.1 Choose the correct or the best alternative in the following: **(2×10)**

a. The Laplace transform of a simple RC integrator circuit shown in Fig.1 is

(A) $\frac{1}{s-a}$ **(B)** $\frac{1}{s+a}$

(C) $\frac{a}{s-a}$ **(D)** $\frac{a}{s+a}$

Where $a=\frac{1}{RC}$

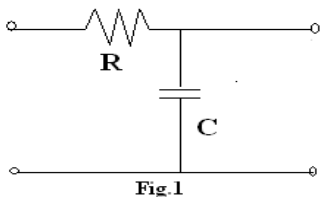

Fig.1

b. According to initial value theorem, the initial value of $f(0^+)$ of a function f(t) is

(A) $f(0^+)=\lim_{s\to0}[sF(s)]$ **(B)** $f(0^+)=\lim_{s\to\infty}[sF(s)]$

(C) $f(0^+)=\lim_{s\to0}[F(s)]$ **(D)** $f(0^+)=\lim_{s\to\infty}[F(s)]$

c. If the characteristic equation of a system is $s^2+8s+25=0$, the value of ω_n and ξ will be

(A) 5 rad/sec, 0.8 **(B)** 0.5 rad/sec, 0.8

(C) 8 rad/sec, 0.5 **(D)** $\sqrt{8}$ rad/sec, 5

d. Number of assymptotes in root locus for the system having open loop transfer function having 5 poles and 2 zero are

(A) 2 **(B)** 5

(C) 1 **(D)** 3

e. The transfer function of a system is $H(s)=\frac{1000}{(1+0.1s)(1+0.01s)}$ the corner frequencies are

(A) 0.1 and 0.01 rad/s **(B)** - 0.1 and - 0.01 rad/s

(C) 10 and 100 rad/s **(D)** -10 and -100 rad/s

f. For $\xi = 1$, the system is

(A) Over damped **(B)** Under damped
(C) Critical damped **(D)** Unstable

g. The phase shift of $G(s) = \frac{1}{s^2}$ is

(A) 90^0 **(B)** -90^0
(C) 180^0 **(D)** -180^0

h. By increasing the gain K of the system, the steady state error of the system

(A) increases **(B)** decreases
(C) remains unaltered **(D)** none of these

i. The resonant peak is given by

(A) $M_r = \frac{1}{2\xi\sqrt{1-\xi^2}}$ **(B)** $M_r = \frac{1}{\xi\sqrt{1-\xi^2}}$

(C) $M_r = \frac{1}{\xi\sqrt{1+\xi^2}}$ **(D)** $M_r = \frac{1}{2\xi\sqrt{1+\xi^2}}$

j. For the given block diagram C(s) / R(s) is

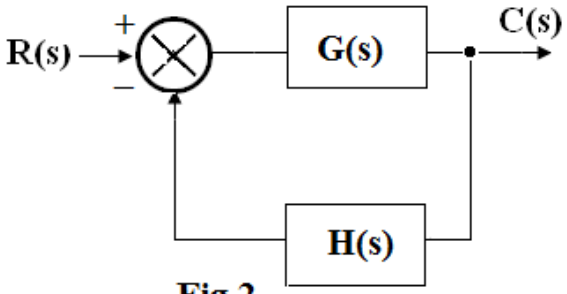

Fig.2

(A) $\frac{G(s)}{1-G(s)H(s)}$

(B) $\frac{G(s)}{1+G(s)H(s)}$

(C) $\frac{H(s)}{1-G(s)H(s)}$

(D) $\frac{H(S)}{1+G(s)H(s)}$

Answer any FIVE Questions out of EIGHT Questions.
Each question carries 16 marks.

Q.2 a. Write the differential equation describing the dynamics of the system shown in Fig.3 and find $\frac{X_2(s)}{F(s)}$ **(8)**

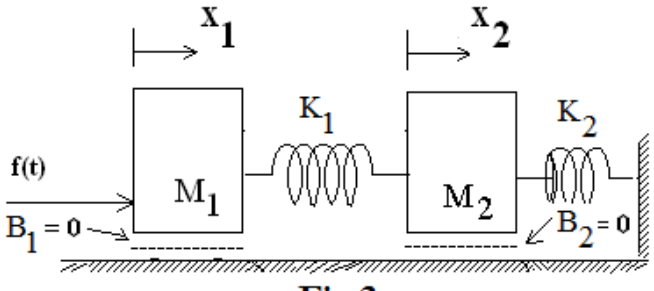

Fig.3

b. Obtain the F-I and F-V analogy of (a).

Q.3 a. In the Fig.4, identify the set of state variables and draw the signal flow graph of the circuit.

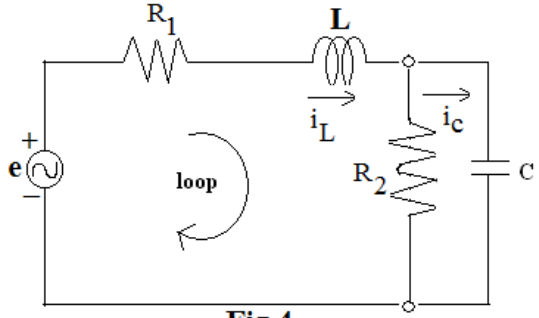

Fig.4

Also, determine transfer function from signal flow graph. **(10)**

b. Find the overall transfer function of the system in Fig.5. **(6)**

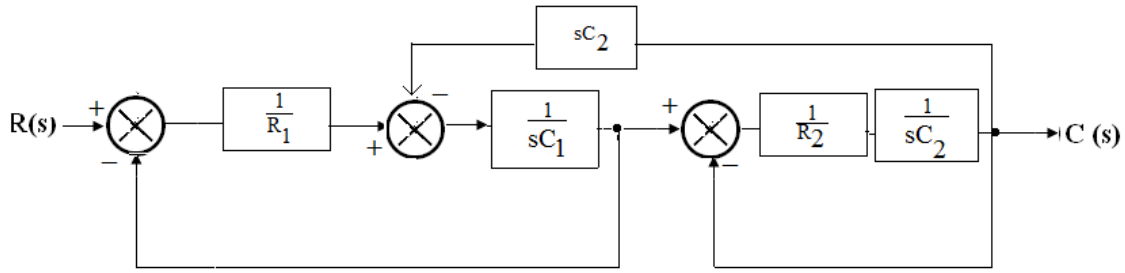

Fig.5

Q.4 a. Explain how the parameter variation is reduced by the use of feedback. **(8)**

b. What are different controller components? Explain in brief. **(8)**

Q.5 a. A second order system with $\xi = 0.5$ and $\omega_n = 6$ rad /sec is subjected to a unit step input. Determine the rise time, peak time, settling time and peak overshoot. **(8)**

b. The transfer function of a unity feedback system is $G(s) = \dfrac{10}{s(s+1)}$.

Find the dynamic error coefficient and steady state error to the input $r(t) = P_0 + P_1 t + P_2 t^2$ **(4)**

c. A unity negative feedback control system has open loop transfer function is $G(s) = \dfrac{K(s+1)(s+2)}{(s+0.1)(s-1)}$ using Routh stability criterion, determine the range of values of K for which the closed loop system has 0,1 or 2 poles in the right – half of S plane. **(4)**

Q.6 a. The open loop transfer function of feedback system is $\dfrac{K}{s(s+4)(s^2+4s+20)}$.

Draw root locus for this system. **(10)**

b. Explain the sensitivity of the roots of the characteristics equation.

Q.7 a. Why logarithmic scale is used for Bode plot ? Sketch the Bode plot for the transfer function H(s) = $\frac{1000}{(1+0.1s)(1+0.001s)}$ determine (i) Phase margin (ii) Gain margin. **(2+6)**

b. The forward path transfer function of a unity feedback control system is G(s) = $\frac{100}{(s+6.54)}$ find the (i) resonance peak (ii) resonance frequency and (iii) bandwidth. **(8)**

Q.8 a. What is the necessity of compensating network? Explain phase lead compensator and give its comparison with phase lag compensator. **(8)**

b. Design a lead compensator for the system shown in Fig. 6. Given that ω_n = 4 rad / sec and ξ = 0.5 for compensated system. **(8)**

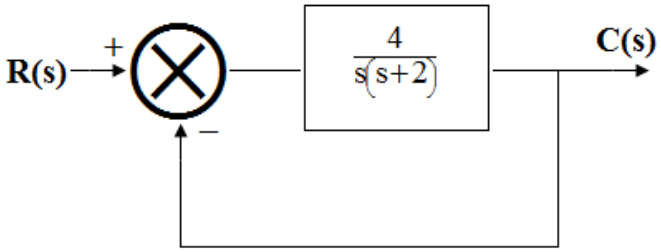

Fig.6

Q.9 a. A system with state model is $\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}1 & 0\\ 1 & 1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}1\\ 1\end{bmatrix}u$

Where u (t) is unit step occurring at t = 0 and $x^T(0) = \begin{bmatrix}1 & 0\end{bmatrix}$. Obtain the time response of the system and compute state transition matrix. **(8)**

b. Test the following system for controllability and observability. **(8)**

$\dot{x} = \begin{bmatrix}-3 & 1 & 1\\ -1 & 0 & 1\\ 0 & 0 & 1\end{bmatrix}x + \begin{bmatrix}0 & 1\\ 0 & 0\\ 2 & 1\end{bmatrix}u$ and $y = \begin{bmatrix}0 & 0 & 1\\ 1 & 1 & 0\end{bmatrix}x$.